★DASE P81 92-351453/43 ★EP 509827-A1

Active matrix type liquid crystal display for office machines and computers - has colour filter substrate comprising colouring layer, transparent electrode and metal film having arbitrary pattern of low resistance (Eng)

SEIKO INSTR INC 91.04.16 91JP-084284
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92.04.16 92EP-303451 R(DE FR GB IT NL)

The active matrix type display unit comprises an active matrix substrate (13) having a number of switches, a colour filter substrate (1) parallel to the active matrix substrate and a liquid crystal material (12) sandwiched between them. The colour substrate (1) comprises a colouring layer (13) having a number of patterns formed on a transparent substrate. A transparent conductive film layer (6) is formed on the colouring layer (3) having a metal film layer (10) arranged in an arbitrary pattern to decrease the resistance of the transparent film.

The thickness of the transparent electrode may be thinned, thereby improving transmition and shortening the time for forming the film.

ADVANTAGE - Improved picture quality and produced cheaper. (5pp Dwg.No.1/4)

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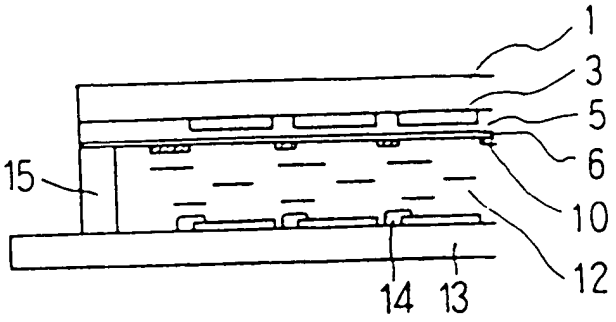

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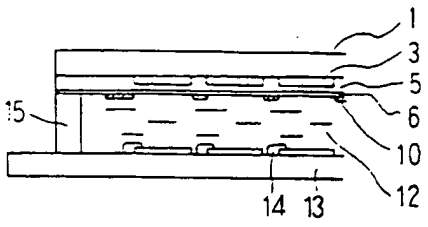
(54) A colour electrooptical device.

(57) An active matrix type multi-colour display unit having high picture quality is provided. The multi-colour display unit has a colour filter substrate (1) comprising a colouring layer (3), a transparent electrode (6) formed on the colouring layer (3) and a metal film (10) having an arbitrary pattern formed on the transparent electrode (6). The resistance of the transparent electrode (6) which has been difficult to lower in the past may be lowered easily by forming the metal layer (10) on it and thereby, the picture quality of the display unit may be improved. Furthermore, since the resistance may be lowered by the metal film (10) even if the resistance value of the transparent electrode (6) itself is high, the thickness of the transparent electrode (6) may be thinned, thereby improving transmittivity of the transparent film and shortening the time for forming the film. The former leads to the further improvement of the picture quality and the later contributes to lowering the cost.

FIG. 1



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The present invention relates to an active matrix type liquid crystal colour display unit used for office automation machines and computer terminal units.

A prior art active matrix type multi-colour display unit is shown in Fig. 4 and comprises a TFT substrate 2 having switching elements 8 and picture element electrodes 9, three primary colour (R, G, B) colouring layers 3, light blocking layers 4 disposed in gaps between the colouring layers 3, a colouring layer protecting film 5 laminated on the colouring layers 3 and a colour filter substrate 1 laminated thereon and comprising a transparent electrode 6 which is a display common electrode. Liquid crystal 7, for example, is pinched between those two electrodes.

Recently, it has been desirable to lower the resistance of the common electrode 6 of the active matrix type multi-colour display unit to improve its picture quality. However, it is not easy to lower the resistance since the common electrode has to be a transparent electrode. Moreover, the transparent electrode has to be formed on the colouring layer which has no heat resistance, so that the conditions for forming the film are restricted, rendering the lowering of the resistance more difficult.

Accordingly, it is an object of the present invention to solve the aforementioned problems and to obtain a high picture quality multi-colour display unit by providing a low resistant common electrode.

It is another object of the present invention to provide low cost colour electrooptical devices.

In order to attain the aforementioned goals, according to the present invention, a metal film is formed as a light blocking film on the common electrode of the colour filter substrate in the multi-colour display unit.

According to the present invention, there is provided a colour electrooptical device comprising:

an active matrix substrate having a plurality of switching elements,

a colour filter substrate parallel to the active matrix substrate; and

a liquid crystal material sandwiched between said active matrix substrate and said colour filter substrate,

wherein the colour filter substrate comprises a colouring layer having a plurality of patterns formed on a transparent substrate, a transparent conductive film layer formed on the colouring layer, and characterised by a metal film layer having an arbitrary pattern formed on the transparent conductive film layer to decrease the resistivity of the transparent conductive film layer.

In the multi-colour display unit structured as described above, the resistance value of the common electrode effectively can be lowered since the metal film is directly formed on it.

Accordingly, the present invention readily enables the resistance of the common electrode to be lowered which has been difficult in the past by forming the metal film on the common electrode as the light blocking film and as a result provides a high picture quality multi-colour display unit.

Furthermore, since the resistance value of the common electrode itself can be high, the thickness of the ITO (Indium Tin Oxide) film for example may be reduced, so that the transmittivity of the ITO may be improved and the time for forming the ITO may be shortened. The former leads to a further improvement of the picture quality of the multi-colour display unit and the latter contributes to the lowering of the cost.

Fig. 1 is a drawing illustrating a first embodiment of the present invention;

Fig. 2 is a drawing illustrating a second embodiment of the present invention;

Fig. 3 is a drawing illustrating a third embodiment of the present invention; and

Fig. 4 is a drawing illustrating a prior art example.

The present invention will be described in the following in connection with the preferred embodiments thereof with reference to accompanying drawings.

Fig. 1 shows a first embodiment. A colour filter substrate 1 was formed first by forming colouring layers 3 typically by a dyeing or printing method, then forming a protection film 5 to protect or flatten the colouring layers and then forming an ITO film 6 by low temperature sputtering.

The colour filter substrate 1 is disposed on an active matrix substrate 13 so as to sandwich a liquid crystal material 12 and sealing material 15. A plurality of switching elements are formed on the active matrix substrate 13 to control the electrical charges for the liquid crystal layer.

The thickness of the film was 1×10^{-7}m and the sheet resistance value was 50 ohms. A chromium (Cr) film was formed thereon and was etched into a grid shape to form light blocking films 10. The resistance value of the ITO could be thus reduced to 10 ohms as a result of the Cr film. It is desirable to have the protection film 5 to improve the reliability of the unit, though it may not be necessary depending on the property of the material of the colouring layer.

When a multi-colour display unit as shown in Fig. 1 was fabricated using this colour filter substrate, a high picture quality display unit having totally no unevenness of contrast across the whole screen could be obtained.

Fig. 2 shows a second embodiment. The colouring layer is formed by electro-deposition in this embodiment and Fig. 2 shows production steps of the colour filter substrate.

An ITO film 11 is formed on an insulating substrate 1 by sputtering or any other suitable method and is etched into an arbitrary pattern in anticipation of the electro-deposition (Fig. 2a). A stripe pattern as shown in Fig. 2f is most suitable.

A colouring layer 3 is formed on the ITO film by electro-deposition (Fig. 2b). If colouring layers for a

plurality of colours are to be formed at this time, the electro-deposition is repeatedly performed per each colour.

A protection film 5 is formed by a spinning method or any other suitable method as shown in Fig. 2c. This protection film may not be necessary. Then an ITO film 6 is formed by sputtering or any other suitable method (Fig. 2d). At this time, since the colouring layer has been already formed on the substrate, during formation of the film the temperature is preferred to be less than 250 °C. In use, this ITO film 6 is used as a driving common electrode of the display unit.

Then a metal film 10, for example chromium (Cr) or other suitable metals, Cr is formed by sputtering or any other such method and is etched so that it can be used as a light blocking film pattern (Fig. 2e). Any patterns, such as a grid pattern as shown in Fig. 2g, may be formed.

The colour filter substrate having a low resistance transparent electrode similar to that in the first embodiment can be fabricated from the above steps and a high picture quality multi-colour display unit can be obtained.

As seen from the present embodiment, the present invention uses a grid shape light blocking film suitable for active matrix type multi-colour display units, so that a low cost multi-colour display unit may be provided.

Fig. 3 shows a third embodiment. A gap m between the colouring layers 3 has a relationship of $m < n$ where n is the width of the light blocking film 10. Thereby obviating any dislocation which may be brought about between the light blocking film 10 and the colour filter 3. Accordingly there is no decrease in the picture quality due to any dislocation and at the same time, yields in the production process can be improved.

Claims

1. A colour electrooptical device comprising:
   an active matrix substrate (13) having a plurality of switching elements;
   a colour filter substrate (1) parallel to the active matrix substrate (13); and
   a liquid crystal material (12) sandwiched between said active matrix substrate (13) and said colour filter substrate (1),
   wherein the colour filter substrate (1) comprises a colouring layer (13) having a plurality of patterns formed on a transparent substrate (1), a transparent conductive film layer (6) formed on the colouring layer (3), and characterised by a metal film layer (10) having an arbitrary pattern formed on the transparent conductive film layer (6) to decrease the resistivity of the transparent conductive film layer (6).

2. A colour electrooptical device according to claim 1;
   wherein a further transparent conductive film layer (5) is also formed between the transparent conductive film layer (6) and the colouring layer (3).

3. A colour electrooptical device according to claim 1 or 2;
   wherein the metal film layer (10) is formed on the transparent conductive film layer (6) over a region between each of the patterns of the colouring layer (3) and shades light transmittance to and from the region.

4. A colour electrooptical device comprising;
   an active matrix substrate (13) having a plurality of switching elements,
   a colour filter substrate (1) parallel to the active matrix substrate (13) at a predetermined gap, and
   a liquid crystal material for filling up the gap for optically changing,
   wherein the colour filter substrate (1) comprises a colouring layer (13) having a plurality of patterns formed on a transparent substrate (1), a transparent conductive film layer (10) having arbitrary pattern formed on the transparent conductive film layer (6) to decrease a resistivity of the transparent conductive film layer (6).

5. A method of forming a colour electrooptical device as claimed in any one of the preceding claims, comprising:
   depositing a colouring layer (3) having a plurality of patterns on a colour filter substrate (1);
   depositing a transparent conductive film layer (6) thereover; characterised by
   depositing a metal film layer (10) having an arbitrary pattern on said transparent conductive film layer (6).

6. A method as claimed in claim 5, wherein said colouring layer (3) is deposited by electro-deposition.

FIG. 1

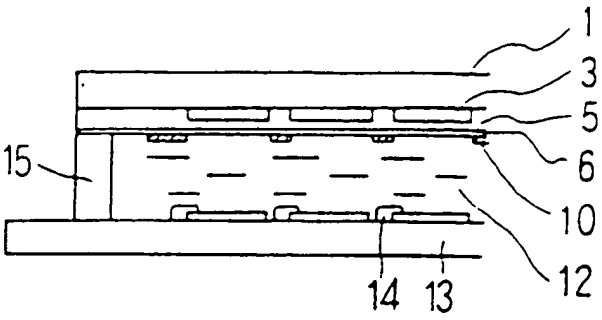


FIG. 2(a)

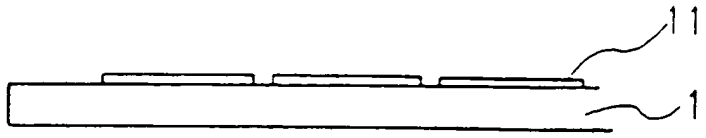


FIG. 2(b)

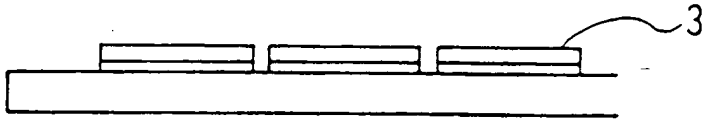


FIG. 2(c)

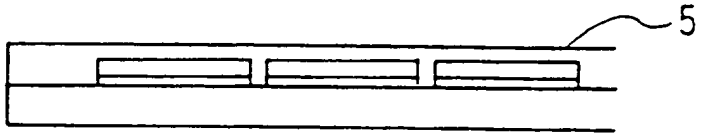


FIG. 2(d)

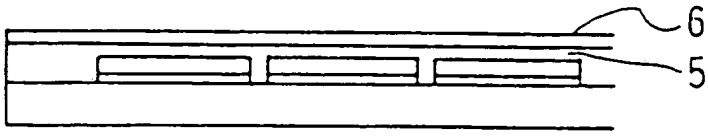


FIG. 2(e)

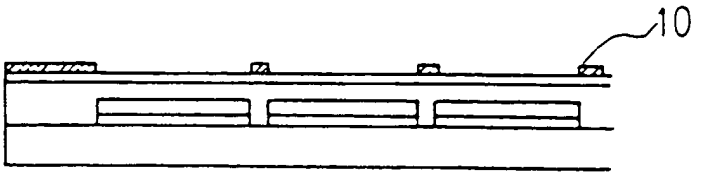


FIG. 2(f)

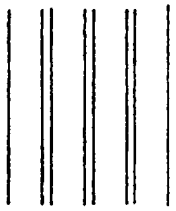


FIG. 2(g)

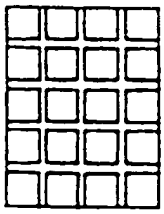


FIG. 3

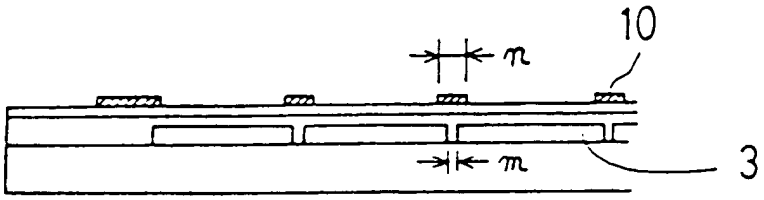
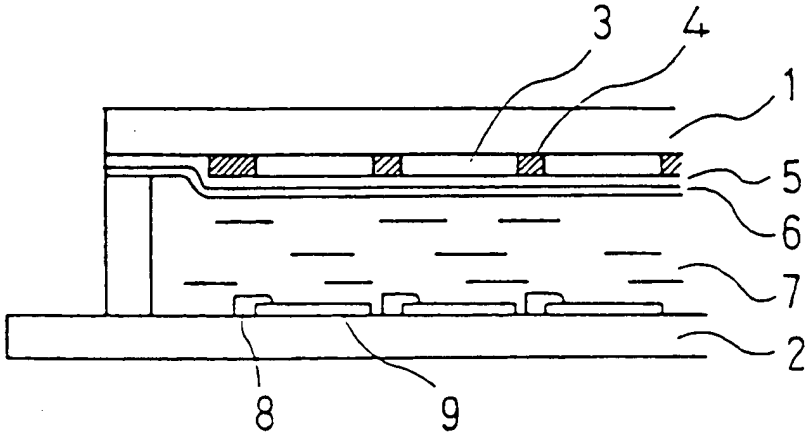


FIG. 4 PRIOR ART



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EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 92303451.6

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP - A - 0 326 112 (TOPPAN PRINTING CO. LTD.)	1-5	G 02 F 1/1343 G 02 F 1/1335
Y	* Column 1, lines 22-54; column 5, line 13 - column 6 line 21; column 7, lines 7-56 *	6	
X	US - A - 4 853 296 (FUKUYOSHI)	1-5	
Y	* Column 1, lines 39-52; fig. 1-7 *	6	
Y	US - A - 4 781 444 (SUGINOYA et al.)	6	
A	* Abstract; claims 1-3 *	1,4	
A	EP - A - 0 332 401 (SEMICONDUCTOR ENERGY LABORATORY CO. LTD.) * Column 1, lines 28-40; column 2, line 7 - column 3, line 5; column 3, lines 28-44 *	1,4,5	TECHNICAL FIELDS SEARCHED (Int. Cl.5) G 02 F 1/00
A	US - A - 4 859 036 (YAMANAKA et al.) * Column 1, lines 12-16; fig. 1,2A,2B *	1,4,5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	22-07-1992	GRONAU

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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